

Preliminary Analysis of Saudi National Seismic Network Recordings of the November 1999 Dead Sea Explosions

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Preliminary Analysis of Saudi National Seismic Network Recordings of the November 1999 Dead Sea Explosions

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Abstract

Two large chemical explosions were detonated in the Dead Sea on November 10 and 11, 1999 for the purposes of calibrating seismic travel times to improve regional network location. These explosions were large enough to be observed with good signal-to-noise ratios by seismic stations in northwestern Saudi Arabia (distances < 500 km). In this report, we present a preliminary analysis of the recordings from these shots.

Introduction

The Dead Sea explosions were recorded by stations of the Saudi National Seismic Network (SNSN) in northeastern Saudi Arabia. The SNSN stations consist primarily of broadband (Streckeisen STS-2) and short-period (Ranger 1-Hz) instrumentation and record at a sampling rate of 100/sec. Figure 1 shows the explosion and station locations. The shot location (star) was taken from the Geophysical Institute of Israel (GII <http://www.gii.co.il>) announcement. The paths range in distance from 180-480 km. At further ranges the signal-to-noise ratio is low. The recorded shot on November 10 had a local magnitude of 3.6 reported by GII. No magnitude information was available for the November 11 shot, but it was recorded with amplitudes roughly a factor of 2 larger than the November 10 shot.

Figures 2 and 3 show the waveforms recorded for the November 10 and 11 shots, respectively. The data were demeaned, tapered and high-pass filtered with a corner frequency of 1 Hz. Inspection of the broadband records revealed no long-period energy (frequencies < 0.2 Hz). Travel times of the main regional phases (Pn, Pg and Sg) were picked from the filtered data. The horizontal components of station DBAS were not working properly at the time of the shots.

Notice the impulsive first arriving P-wave observed at QURS. This is probably the crustal P-wave, Pg. This phase is seen on the more distant records. At station ALWS the first arriving P-wave is probably Pn and is followed by Pg. At further stations the Pn and

Pg arrivals become more separated in time. The crustal S-wave, Sg, is best observed on the horizontal components but is still difficult to pick with high accuracy. The mantle S-wave, Sn, was difficult to observe on all traces and was not picked.

Travel Times

Figure 4 shows the travel times versus distance from which apparent velocities may be inferred. The arrivals from both shots are plotted. The travel times were calculated using the announced location and origin time (Table 2). Apparent velocities are shown assuming an intercept time for P- and S-waves of 5 and 10 seconds, respectively. Notice that the Pn, Pg and Sg phases arrive with apparent velocities of 8.0, 6.5 and 3.8 km/s, respectively. These travel times may be used to develop a velocity model for regional network location for the Gulf of Aqaba region.

SNSN Event Locations

Figure 1 also shows the automatic locations from the SNSN real-time system. These locations are based on automatically detected P-waves and the iasp91 velocity model. While not in agreement with the ground truth, the automatic locations are reasonably good. The mislocation from the reported ground truth is given in Table 1. The location can be improved by using human analyst travel picks and a better velocity model.

Conclusions

The Saudi National Seismic Network recorded the Dead Sea shots with good signal-to-noise out to ranges of almost 500 km. These recordings provide an excellent data source for the development of a regional velocity model. Future research will focus on velocity model development and magnitude calibration.

Acknowledgements

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Table 1. Automatic Locations of Dead Sea Shots by Saudi National Seismic Network.

Latitude	Longitude	Date	Time (GMT)	Mislocation (km)
31.6214	35.1506	Nov. 10, 1999	13:59:58.807	29.108
31.8143	35.0178	Nov. 11, 1999	14:59:58.572	50.712

Table 2. Ground Truth Location from Geophysical Institute of Israel

Latitude	Longitude	Date	Time (GMT)	Yield (kg TNT)
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31.5338	35.4400	Nov. 10, 1999	13:59:52.200	2060
31.5336	35.4413	Nov. 11, 1999	15:00:00.785	5000

Saudi National Seismic Network and the Nov, 1999 Dead Sea Shots

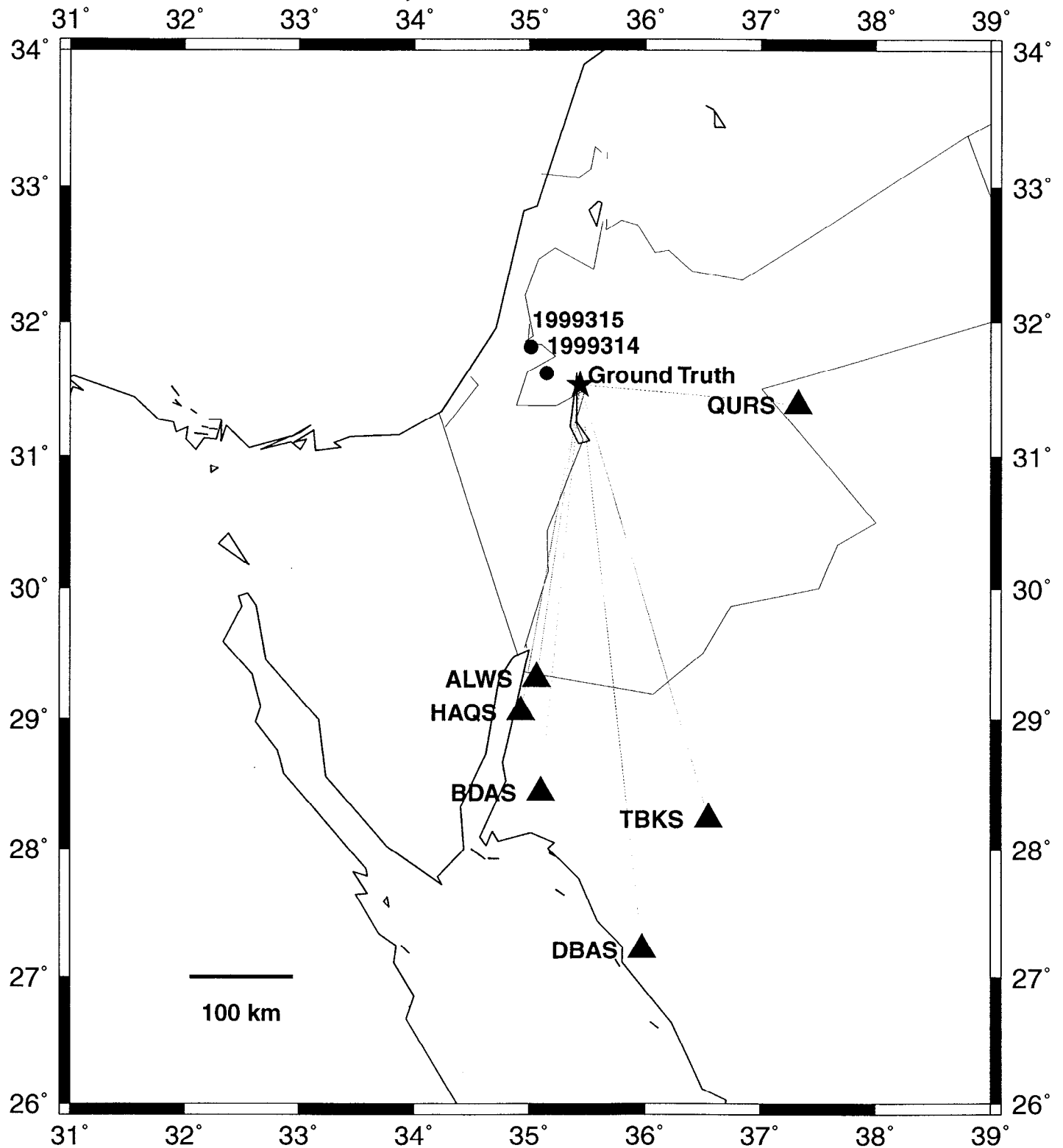


Figure 1. Map showing the locations of the Dead Sea shots and the SNSN stations that recorded the shots.

Saudi National Seismic Network Recordings of the Nov 10, 1999 Dead Sea Shot

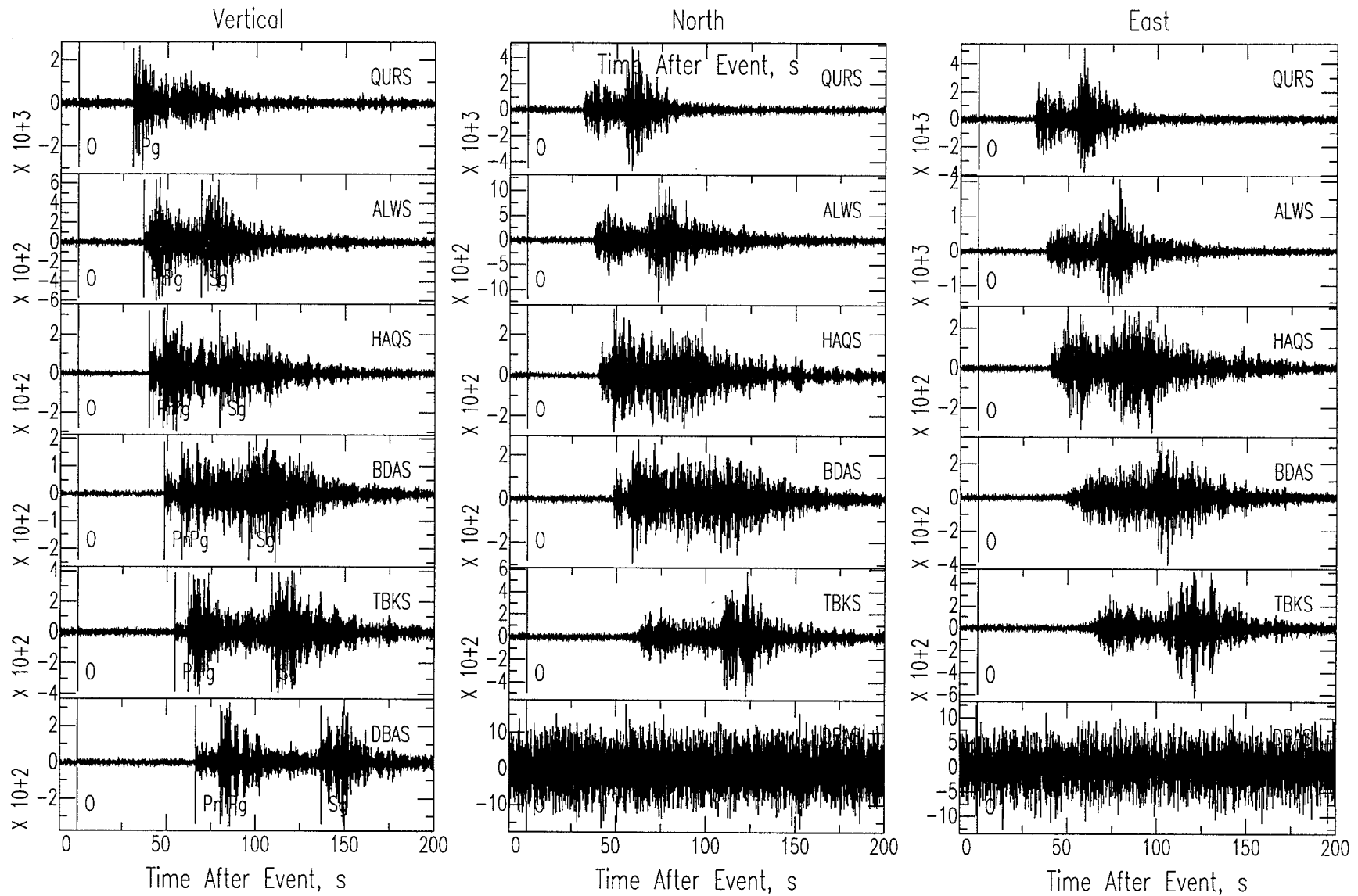


Figure 2. Waveforms for the November 10, 1999 shot, high-pass filtered with a corner frequency of 1 Hz. Note that all traces are plotted on a different scale.

Saudi National Seismic Network Recordings of the Nov 11, 1999 Dead Sea Shot

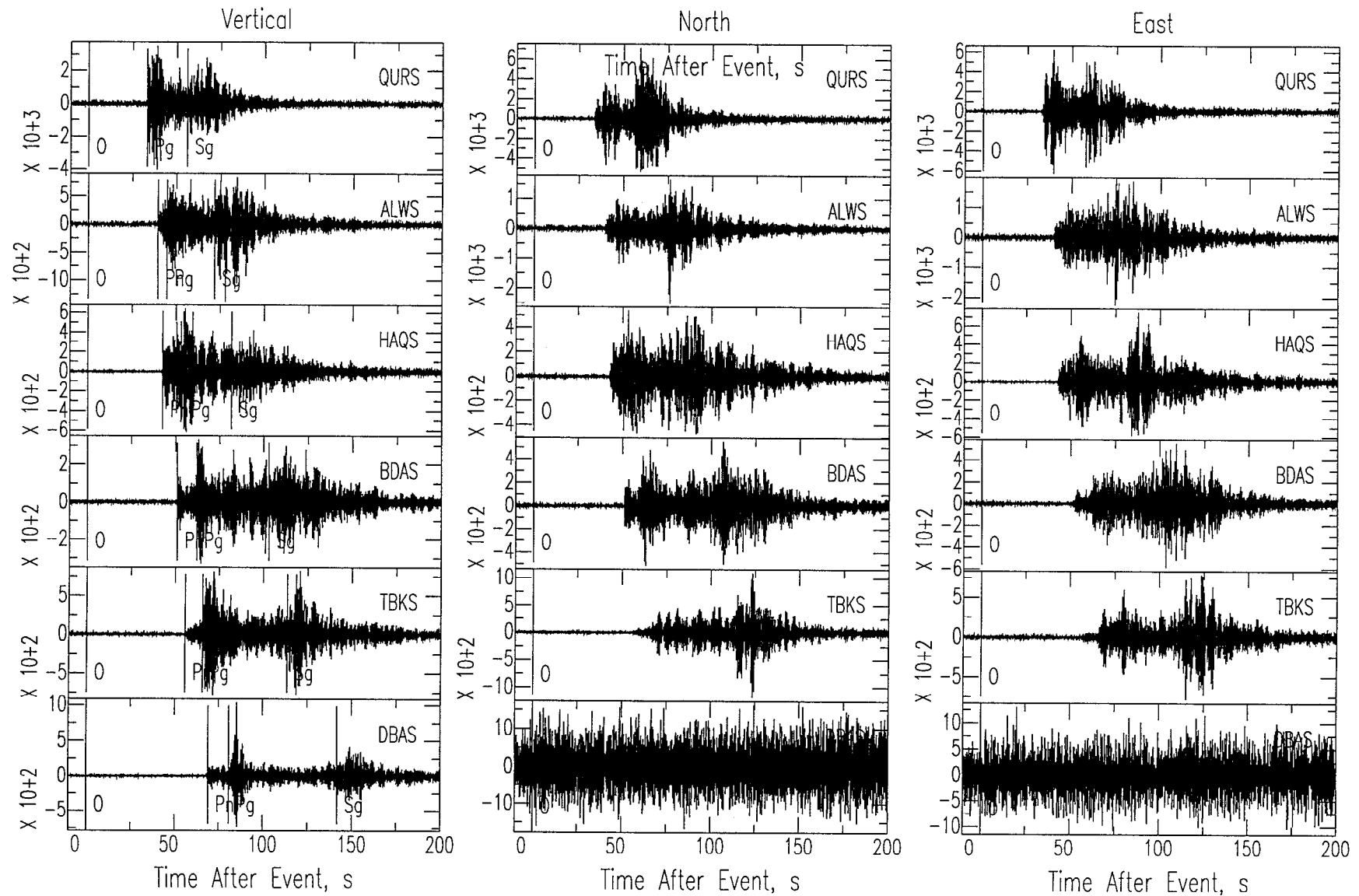


Figure 3. Waveforms for the November 11, 1999 shot, high-pass filtered with a corner frequency of 1 Hz. Note that all traces are plotted on a different scale.

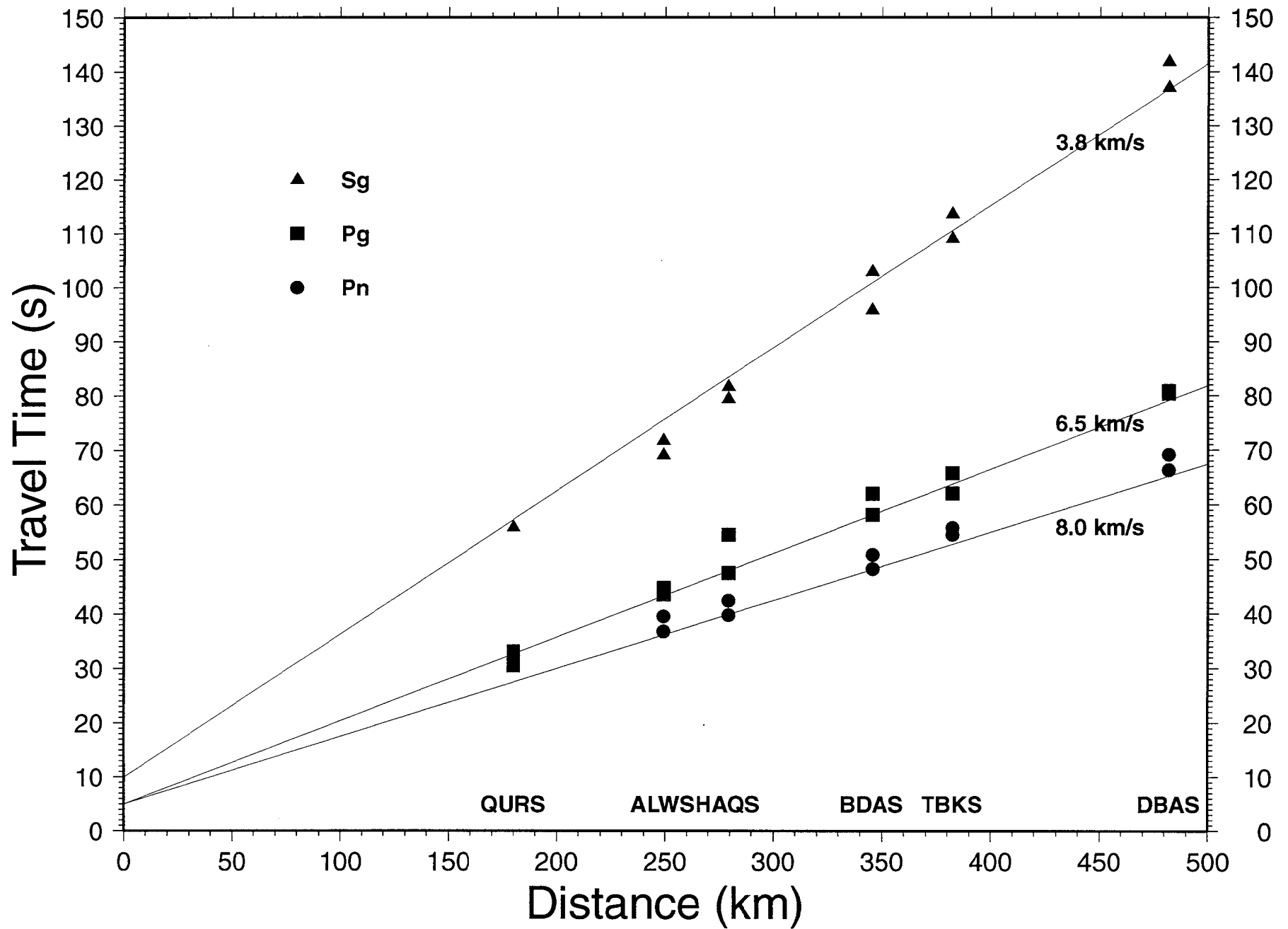


Figure 4. Travel times for regional phases Pn, Pg and Sg plotted as a function of distance.